

# Claims

- [c1] In a locomotive having one or more pneumatic brake cylinders, a brake pipe, an independent application and release pipe and an actuating pipe, an electronic braking control comprising:
- a pneumatic manifold containing pneumatic links to said one or more pneumatic brake cylinders and said brake pipe;
  - one or more field replaceable portions for controlling the pressure in said one or more pneumatic brake cylinders and in said brake pipe, said independent application and release pipe and said actuating pipe, said portions being pneumatically linked to said pneumatic manifold; and
  - an electronic microcontroller for executing software specific to the function of each of said one or more field replaceable portions;
- wherein said pneumatic links between said field replaceable portions and said pneumatic manifold are automatically made when said field replaceable portions are physically secured to said pneumatic manifold.
- [c2] The electronic braking control of Claim 1 wherein each of said field replaceable units has an electrical connec-

tion, said electrical connection providing power and external inputs and outputs for said portions.

- [c3] The electronic braking control of Claim 2, further comprising a brake handle unit containing one or more brake handles, said one or more field replaceable portions responding to changes in the position of said one or more brake handles.
- [c4] The electronic braking control of Claim 3, wherein said brake handle unit comprises an independent brake handle and an automatic brake handle
- [c5] The electronic braking control of Claim 1, wherein said one or more field replaceable portions includes a brake cylinder control portion for controlling the pressure in said one or more pneumatic brake cylinders.
- [c6] The electronic braking control of Claim 1, wherein said one or more field replaceable portions includes a brake pipe control portion for controlling the pressure in said brake pipe.
- [c7] The electronic braking control of Claim 1, wherein said one or more field replaceable portions includes an IAR/ACT pipe control portion for controlling the pressure in said independent application and release pipe and said actuating pipe

- [c8] The electronic braking control of Claim 1 wherein each of said electronic microcontrollers in said one or more portions is in communication with the others of said electronic microcontrollers over a common network.
- [c9] The electronic braking control of Claim 8, wherein said electronic microcontrollers each comprise:  
redundant, independent microprocessors, each of said microprocessors running copies of said software; and  
a redundancy control circuit for choosing which of said one or more microprocessors controls the outputs of said electronic microcontroller.
- [c10] The electronic braking control of Claim 9, wherein each of said field replaceable portions further comprises:  
a plurality of pressure transducers for sensing pressures;  
and  
a plurality of solenoids for opening and closing valves;  
and  
further wherein each of said electronic microcontrollers further comprises:  
a plurality of inputs for reading said plurality of pressure transducers; and  
a plurality of outputs for controlling said plurality of solenoids, based on said portion-specific software.
- [c11] The electronic braking control of Claim 10, wherein said

redundancy control circuit assigns one of said redundant microprocessors in said electronic microcontroller to control said plurality of outputs for controlling said solenoids.

- [c12] In a locomotive having one or more pneumatic brake cylinders, a brake pipe, an independent application and release pipe and an actuating pipe, an electronic braking control comprising:  
one or more portions for controlling the pressure in said one or more pneumatic brake cylinders and in said brake pipe, said independent application and release pipe and said actuating pipe; and  
a plurality of distributed electronic microcontrollers, one of said distributed microcontrollers controlling each of said one or more portions, said distributed microcontrollers being linked to each other via a network.
- [c13] The electronic braking control of claim 12 further comprising one or more redundant networks linking said plurality of distributed microcontrollers
- [c14] The electronic braking control of Claim 13, wherein each of said microcontrollers contains software implementing functions specific to the portion with which it is installed.
- [c15] The electronic braking control of Claim 12, further com-

prising:

a brake handle unit having an independent brake handle and an automatic brake handle, said brake handle unit being coupled to said network of distributed microcontrollers, said plurality of microcontrollers receiving signals from said brake handle unit via said network regarding the movement and position of said independent and said automatic brake handles

[c16] The electronic braking control of Claim 14, wherein each of said microcontrollers comprises:

one or more redundant microprocessors independently running said software; and

a redundancy control portion for selecting which of said one or more microprocessors controls the functions of said portion in which said microcontroller is installed.

[c17] The electronic braking control of Claim 16 wherein each one of said one or more redundant microprocessors is linked to one of said one or more redundant networks connecting said plurality of microcontrollers.

[c18] The electronic braking control of Claim 17, wherein each of said portions further comprises:

a plurality of pressure transducers for sensing pressures; and

a plurality of solenoids for opening and closing valves;

and

further wherein each of said microcontrollers further comprises:

a plurality of inputs for reading said plurality of pressure transducers; and

a plurality of outputs for controlling said plurality of solenoids, based on said portion-specific software.

[c19] The electronic braking control of Claim 18, wherein said redundancy control circuit assigns one of said redundant microprocessors in said electronic microcontroller to control said plurality of outputs for controlling said solenoids for the portion in which it is installed.

[c20] The electronic braking control of Claim 19, wherein said redundancy control circuit receives a periodic watchdog signal and a fault signal from each of said redundant microprocessors.

[c21] The electronic braking control of Claim 15, further comprising:  
a gateway linking said one or more redundant networks with a locomotive network; and  
translating circuitry for translating messages to and from a format compatible with said locomotive network.

[c22] The electronic braking control of Claim 12 wherein said

one or more portions includes a brake cylinder control portion for controlling the pressure in said one or more pneumatic brake cylinders based on changes in pressure in said brake pipe, said independent application and release pipe and said actuating pipe.

[c23] The electronic braking control of Claim 12 wherein said one or more portions includes a brake cylinder control portion for controlling the pressure in said one or more pneumatic brake cylinders based on messages received by said microcontroller over said network.

[c24] The electronic braking control of Claim 12, wherein said one or more portions includes a brake pipe control portion for controlling the pressure in said brake pipe.

[c25] The electronic braking control of Claim 12, wherein said one or more portions includes an IAR/ACT control portion for controlling the pressure in said independent application and release pipe and said actuating pipe

[c26] The electronic braking control of Claim 12, wherein said one or more portions includes:  
a brake cylinder control portion for controlling the pressure in said one or more pneumatic brake cylinders;  
a brake pipe control portion for controlling the pressure in said brake pipe; and

a IAR/ACT control portion for controlling the pressure in said independent application and release pipe and said actuating pipe

- [c27] The electronic braking control of Claim 17 wherein said portions control said pressures under the control of said software running in said distributed microcontrollers, said microcontrollers receiving input from:  
said brake cylinders, said brake pipe, said independent application and release pipe and said actuating pipe via a plurality of transducers read by said microcontrollers;  
said brake handle unit, via said network; and  
a computer located on said locomotive, via said gateway between said network and said locomotives network.
- [c28] The electronic braking control of Claim 27 wherein said microcontrollers control said pressures via a plurality of solenoid-controlled valves
- [c29] The electronic braking control of Claim 28, wherein said redundancy control circuitry decides which of said redundant micro processors and said micro controller controls said solenoid-controlled valves
- [c30] In a locomotive having one or more pneumatic brake cylinders, a brake pipe, an independent application and release pipe and an actuating pipe, an electronic braking



control comprising:

a pneumatic manifold containing pneumatic links to said one or more pneumatic brake cylinders, said brake pipe, said independent application and release pipe and said actuating pipe;

a brake cylinder control portion for controlling the pressure in said one or more brake cylinders, said brake cylinder control portion being pneumatically linked to said pneumatic manifold and said brake cylinder control portion being controlled by a microcontroller;

a brake pipe control portion, for controlling the pressure in said brake pipe; said brake pipe control portion being pneumatically linked to said pneumatic manifold and said brake pipe control portion being controlled by a microcontroller; and

an IAR/ACT control portion, for controlling the pressure in said independent application and release pipe and said actuating pipe, said IAR/ACT control portion being pneumatically linked to said pneumatic manifold and said IAR/ACT control portion being controlled by a microcontroller;

wherein said brake cylinder control portion, said brake pipe control portion, and said IAR/ACT control portion are field replaceable units and wherein said pneumatic links between said portions and said pneumatic manifold are automatically connected when said portions are

physically secured to said pneumatic manifold; and further

wherein said microcontrollers controlling said portions are arranged in a distributed manner and are linked via one or more networks.